

WHAT IS CLAIMED IS:

Sub-
A
5 1. A vehicle driving apparatus, which is installed in a vehicle that has an engine connected to a drive shaft, wherein the apparatus automatically stops the engine if a predetermined condition for stopping the engine is satisfied and automatically starts the engine if a predetermined condition for starting the engine is satisfied, wherein the vehicle includes an auxiliary device that is connected to the
10 engine, and the apparatus comprises:

a motor generator, wherein the motor generator is selectively connected to the engine;

15 a connecting mechanism, wherein the connecting mechanism connects the motor generator to the auxiliary device, and the connecting mechanism selectively connects the motor generator to the engine;

20 an auxiliary device driving means, wherein the auxiliary device driving means enables the connecting mechanism to disconnect the motor generator from the engine and drives the auxiliary device through the motor generator in response to a request to drive the auxiliary device when the engine is maintained in an automatically stopped state;

25 a vibration suppressing means, wherein the vibration suppressing means controls rotation of the drive shaft of the engine in the stopped state through the motor generator for suppressing vibration caused by stopping of the engine when the engine stopping condition is satisfied;

30 a vehicle starting means, wherein the vehicle starting means controls the rotation of the drive shaft of the engine through the motor generator for generating force to move the vehicle when the engine starting condition is satisfied;

35 an engine starting means, wherein the engine starting means starts the engine through the rotation of the drive shaft of the engine controlled by the vehicle starting means when the engine starting condition is satisfied; and

a traveling-mode power generating means, wherein the traveling-mode power generating means enables the motor generator to generate power through the rotation of the drive shaft of the engine when the vehicle is traveling.

5

2. The apparatus according to claim 1, further comprising:

an energy recovering means, wherein the energy recovering means enables the connecting means to connect the motor generator to the engine and enables the motor generator to generate power through the rotation of the drive shaft of the engine for recovering energy generated by movement of the vehicle when fuel supply to the engine is suspended due to deceleration of the vehicle; and

10

15

20

25

30

35

an engine stall preventing means, wherein the engine stall preventing means enables the connecting mechanism to connect the motor generator to the engine and enables the motor generator to increase the engine speed for preventing an engine stall from occurring if the engine speed becomes lower than a reference value after the fuel supply to the engine is resumed.

3. The apparatus according to claim 1, wherein the connecting mechanism includes:

25

a rotation transmitting mechanism that connects the motor generator to the auxiliary device; and

a clutch mechanism that selectively connects the rotation transmitting mechanism to the drive shaft of the engine.

30

35

4. The apparatus according to claim 3, wherein the rotation transmitting mechanism includes a pulley and a belt, and the clutch mechanism is located at the drive shaft of the engine and has a pulley that is connected to the belt of the rotation transmitting mechanism and a switching mechanism that selectively connects the pulley to the drive shaft of the

engine.

5. The apparatus according to claim 3, wherein the rotation transmitting mechanism includes a sprocket and a chain, and the clutch mechanism is located at the drive shaft of the engine and includes:

a sprocket that is connected to the chain of the rotation transmitting mechanism; and

a switching mechanism that selectively connects the sprocket to the drive shaft of the engine.

6. The apparatus according to claim 3, wherein the rotation transmitting mechanism includes a plurality of gears, and the clutch mechanism includes:

a clutch gear that is connected to the gears of the rotation transmitting mechanism; and

a switching mechanism that selectively connects the clutch gear to the drive shaft of the engine.

7. The apparatus according to claim 3, further comprising:

a torque converter, which is connected to the drive shaft of the engine; and

an automatic transmission, which is connected to the torque converter.

8. The apparatus according to claim 7, wherein the torque converter is connected to a first end of the drive shaft of the engine, and the clutch mechanism is connected to a second end of the drive shaft, wherein the second end is opposite to the first end.

9. The apparatus according to claim 3, wherein the connecting mechanism reduces the rotation speed of the motor generator and rotates the drive shaft of the engine in

accordance with the reduced rotation speed when the clutch mechanism connects the motor generator to the engine.

5 10. The apparatus according to claim 1, wherein the engine includes a throttle valve that adjusts the amount of air supplied to the engine, and the vibration suppressing means temporarily rotates the drive shaft of the engine, in which the throttle valve is fully closed, at a speed equal to an idle speed through the rotation of the motor generator for
10 reducing the pressure in each cylinder of the engine when the engine is stopped.

11. The apparatus according to claim 1, wherein the vehicle includes an accelerator pedal, and the engine starting
15 means starts the engine after maintaining the engine speed at a predetermined value for a predetermined time if the accelerator pedal is not depressed.

12. The apparatus according to claim 2, wherein the
20 connecting mechanism includes:

a rotation transmitting mechanism that connects the motor generator to the auxiliary device; and

a clutch mechanism that selectively connects the rotation transmitting mechanism to the drive shaft of the engine.
25

13. The apparatus according to claim 12, wherein the rotation transmitting mechanism includes a pulley and a belt, and the clutch mechanism is located at the drive shaft of the engine and has a pulley that is connected to the belt of the
30 rotation transmitting mechanism and a switching mechanism that selectively connects the pulley to the drive shaft of the engine.

14. The apparatus according to claim 12, wherein the
35 rotation transmitting mechanism includes a sprocket and a

chain, and the clutch mechanism is located at the drive shaft of the engine and includes:

a sprocket that is connected to the chain of the rotation transmitting mechanism; and

5 a switching mechanism that selectively connects the sprocket to the drive shaft of the engine.

10 15. The apparatus according to claim 12, wherein the rotation transmitting mechanism includes a plurality of gears, and the clutch mechanism includes:

a clutch gear that is connected to the gears of the rotation transmitting mechanism; and

a switching mechanism that selectively connects the clutch gear to the drive shaft of the engine.

15 16. The apparatus according to claim 12, further comprising:

a torque converter, which is connected to the drive shaft of the engine; and

20 an automatic transmission, which is connected to the torque converter.

25 17. The apparatus according to claim 16, wherein the torque converter is connected to a first end of the drive shaft of the engine, and the clutch mechanism is connected to a second end of the drive shaft, wherein the second end is opposite to the first end.

30 18. The apparatus according to claim 12, wherein the connecting mechanism reduces the rotation speed of the motor generator and rotates the drive shaft of the engine in accordance with the reduced rotation speed when the clutch mechanism connects the motor generator to the engine.

35 19. The apparatus according to claim 2, wherein the

engine includes a throttle valve that adjusts the amount of air supplied to the engine, and the vibration suppressing means temporarily rotates the drive shaft of the engine, in which the throttle valve is fully closed, at a speed equal to an idle speed through the rotation of the motor generator for reducing the pressure in each cylinder of the engine when the engine is stopped.

20. The apparatus according to claim 2, wherein the vehicle includes an accelerator pedal, and the engine starting means starts the engine after maintaining the engine speed at a predetermined value for a predetermined time if the accelerator pedal is not depressed.

21. A method for controlling a vehicle driving apparatus that includes a motor generator, an auxiliary device, and a connecting mechanism that connects the motor generator to the auxiliary device and selectively connects the motor generator to an engine, comprising:

automatically stopping the engine when a predetermined condition for stopping the engine is satisfied;

automatically starting the engine when a predetermined condition for starting the engine is satisfied;

enabling the connecting mechanism to disconnect the motor generator from the engine and driving the auxiliary device through the motor generator in response to a request to drive the auxiliary device when the engine is maintained in an automatically stopped state;

suppressing vibration caused by stopping of the engine by enabling the connecting mechanism to connect the motor generator to the engine and controlling shaft rotation of the engine in the stopped state through the motor generator when the engine stopping condition is satisfied;

enabling the connecting mechanism to connect the motor generator to the engine and controlling the shaft rotation of

the engine through the motor generator for generating force to move a vehicle when the engine starting condition is satisfied;

starting the engine through the shaft rotation of the engine when the engine starting condition is satisfied; and

enabling the connecting mechanism to connect the motor generator to the engine and enabling the motor generator to generate power through the engine when the vehicle is traveling.

22. The method according to claim 21, further comprising:

enabling the connecting mechanism to connect the motor generator to the engine and enabling the motor generator to generate power through shaft rotation of the engine for recovering energy generated by movement of the vehicle when a fuel supply to the engine is suspended due to deceleration of the vehicle; and

enabling the connecting mechanism to connect the motor generator to the engine and increasing the engine speed through the motor generator for preventing an engine stall if the engine speed becomes lower than a reference value after the fuel supply is resumed.

23. A vehicle driving apparatus, which is installed in a vehicle that has an engine connected to a drive shaft, wherein the apparatus automatically stops the engine if a predetermined condition for stopping the engine is satisfied and automatically starts the engine if a predetermined condition for starting the engine is satisfied, and the apparatus comprises:

a motor generator, wherein the motor generator is selectively connected to the engine;

a connecting mechanism, wherein the connecting mechanism selectively connects the motor generator to the engine;

a vibration suppressing means, wherein the vibration suppressing means controls rotation of the drive shaft of the engine in the stopped state through the motor generator for suppressing vibration caused by stopping of the engine when the engine stopping condition is satisfied;

a vehicle starting means, wherein the vehicle starting means controls the rotation of the drive shaft of the engine through the motor generator for generating force to move the vehicle when the engine starting condition is satisfied; and

an engine starting means, wherein the engine starting means starts the engine through the rotation of the drive shaft of the engine controlled by the vehicle starting means when the engine starting condition is satisfied.

24. The apparatus according to claim 23, further comprising:

an engine stall preventing means, wherein the engine stall preventing means enables the connecting mechanism to connect the motor generator to the engine and enables the motor generator to increase the engine speed for preventing an engine stall from occurring if the engine speed becomes lower than a reference value after the fuel supply to the engine is resumed.

25. A vehicle driving apparatus, which is installed in a vehicle that has an engine connected to a drive shaft, wherein the apparatus automatically stops the engine if a predetermined condition for stopping the engine is satisfied and automatically starts the engine if a predetermined condition for starting the engine is satisfied, and the apparatus comprises:

a motor generator, wherein the motor generator is selectively connected to the engine;

a connecting mechanism, wherein the connecting mechanism selectively connects the motor generator to the engine; and

a control circuit, wherein the control circuit controls rotation of the drive shaft of the engine in the stopped state through the motor generator for suppressing vibration caused by stopping of the engine when the engine stopping condition is satisfied, controls the rotation of the drive shaft of the engine through the motor generator for generating force to move the vehicle when the engine starting condition is satisfied, and starts the engine through the rotation of the drive shaft of the engine when the engine starting condition is satisfied.

26. The apparatus according to claim 25, wherein the control circuit enables the connecting mechanism to connect the motor generator to the engine and enables the motor generator to increase the engine speed for preventing an engine stall from occurring if the engine speed becomes lower than a reference value after the fuel supply to the engine is resumed.